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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/36

A1

(11) International Publication Number: WO 97/41704

(43) International Publication Date: 6 November 1997 (06.11.97)

(21) International Application Number: PCT/SE97/00501

(22) International Filing Date: 24 March 1997 (24.03.97)

(30) Priority Data:
9601613-4 29 April 1996 (29.04.96) SE

(71) Applicant (*for all designated States except US*): RADIO DESIGN INNOVATION AB [SE/SE]; P.O. Box 1223, S-164 28 Kista (SE).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): JOHNSON, Torbjörn [SE/SE]; Lidvägen 1, S-175 40 Järfälla (SE). ENWALL, Lars [SE/SE]; Pingstvägen 30, S-126 36 Hägersten (SE).

(74) Agents: HOLMQVIST, Lars, J., H. et al.; Albihn Holmqvist AB, P.O. Box 4289, S-203 14 Malmö (SE).

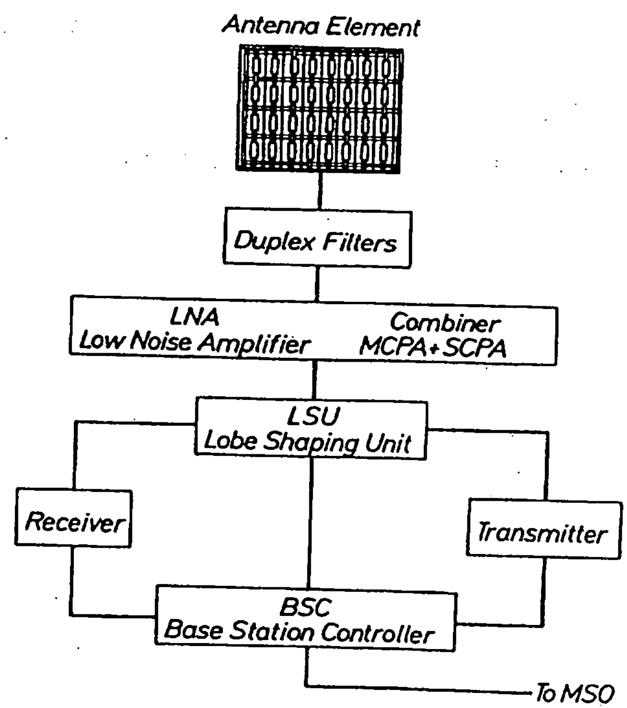
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND ARRANGEMENT OF CONVERTING A CELLULAR TELECOMMUNICATION SYSTEM

(57) Abstract

The present invention relates to a method and an arrangement of converting a cellular telecommunication system. The invention is primarily intended for migration from an analogue cellular mobile telephony system to a digital cellular mobile telephony system while upholding both analog and digital traffic within a given operator allocated frequency band. Thus, the present invention provides a method and an arrangement for converting a cellular telecommunication system of a first type to a cellular telecommunication system of a second type including mobile switching offices, base stations and mobile units. The method comprises the steps of increasing the traffic handling capacity of the first type of system, introducing generic base station equipment capable of supporting both types of system and shifting the radio resource utilization as desired or necessary from the first type of system to the second type of system by reconfigurating the generic base station equipment. The invention preferably includes introducing multi-cell sites comprising phased array antennas having fixed or controllable multilobe properties. Suitably, the step of reconfigurating the generic base station equipment includes reprogramming of software of the base station.



TITLE OF INVENTION: METHOD AND ARRANGEMENT OF CONVERTING A CELLULAR TELECOMMUNICATION SYSTEM

Field of the invention

The present invention relates to a method and an arrangement of converting a cellular telecommunication system and more particularly, a method and arrangement for migrating a cellular telecommunication system of a first type to a cellular telecommunication system of a second type. The migration is performed step by step but is at the same time seamless, i.e. there is no interruption of the telecommunication traffic. The invention is primarily intended for migration from an analogue cellular mobile telephony system to a digital cellular mobile telephony system while upholding both analog and digital traffic within a given operator allocated frequency band.

The invention is related to the following patent applications with the same filing date as the present application or to be filed in the near future, having the same owner as the present application and entitled:

ANTENNA SYSTEM;
ROTATING LOBE ACCESS METHOD;
ADAPTIVE AIR INTERFACE;
ADAPTIVE RADIO RECEIVER APPARATUS;
TRANSMITTER COMBINER ARRANGEMENT;
SELF-SUPPORTING RADIO BASE STATION

State of the art

The technological status of the analog cellular mobile telephony standard of today has a history going back to the late 70-ties. The present technology is a development of the systems from the early days.

The early systems (and analog systems of today) have a

MSO (Mobile Switching Office) to take care of switching of the mobile network into the PSTN (Public Switched Telecommunication Network). The MSO is also responsible for channel allocation and hand-off in the network.

The base stations are mostly omnidirectional sites (circular cells) or trisector sites (3 x 120° cells). At the time of design it was considered to be enough with this cell structure. The antennas used are omnidirectional or 60° sectorized antennas with low antenna gain requiring high power RF (Radio Frequency) transmitters in both the base station and in the mobile unit.

Due to the methods used to design the early analog systems many limitations on the specification plane were built in. These limitations are today becoming visible when the networks are reaching their capacity limits.

One previously known way to increase the capacity of the existing analog system is to decrease the cell size and increase the cell density. This method has technical and economical limits. When the limits are reached further capacity improvements are not feasible.

In order to increase the capacity in the mobile telephone networks the digital technology was introduced in the 80-ties. The digital technology gives a significant increase in capacity. Analog system operators are today looking at the digital technology as a means to overcome the capacity problems.

When an analog cellular mobile telephony system is migrated to a digital cellular mobile telephony system there are a lot of unsolved problems. One of the used methods is to build a new digital system in parallel with the existing analog system and to attract new subscribers to the new system. This method means that the operator have to obtain new frequency spectrum for the new system which is hard and very costly. Furthermore, the operator will have to operate two parallel systems which will be very costly and inefficient.

The other method used today is for example used when analog AMPS (American Mobile Phone System) systems are replaced with digital AMPS (DAMPS) systems. With this method

a parallel digital system is added to the existing analog system using the same infrastructure in terms of sites and MSO. The digital system is then put into operation within the same frequency spectrum as the analog system. This creates two problems for the operator.

The analog subscriber terminals will not work in the digital system which is unacceptable to the subscribers. The problem is solved by keeping parts of the system in operation as an analog system using part of the frequency spectrum iniatially allocated for analog operation.

Since the reason for migrating to a digital system was congestion and lack of capacity in the analog system most of the available frequency band will be used for analog operation leaving only a minor part of the available frequency spectrum for capacity enhancing digital technology. The end result will be a very small increase in capacity at a high cost. The general problem with migration from analog systems to digital systems is the fact that when the frequency spectrum is fully used for analog operation there is very little to gain from digitalization of the network unless a big portion of the analog subscribers are forced to change to digital terminals.

There is therefore a need for a method that will solve the problem with the migration from an analog system to a digital system.

<u>Summary of the invention</u>

The present invention solves the above-mentioned problems by providing a method of converting a cellular telecommunication system of a first type to a cellular telecommunication system of a second type including mobile switching offices, base stations and mobile units.

The method comprises the steps of increasing the traffic handling capacity of the first type of system, introducing generic base station equipment capable of supporting both types of system and shifting the radio resource utilization as desired or necessary from the first type of system to the second type of system by reconfigurating the generic base station equipment.

The method according to the invention preferably in-

cludes introducing multicell sites comprising phased array antennas having fixed or controllable multilobe properties. Suitably, the step of reconfigurating the generic base station equipment includes reprogramming of software of the base station.

The present invention also relates to an arrangement for converting a cellular telecommunication system of a first type to a cellular telecommunication system of a second type.

The invention and further developments of the invention are set out in detail in the accompanying claims.

Brief description of the drawings

The present invention is described more in detail below with reference to the accompanying drawings, wherein:

Figs. 1A, 1B and 1C are an elevation view, a side view and a top view, respectively, of a section of a phased array antenna according to the invention;

Figs. 2A to 2D are different antenna lobe diagrams;

Fig. 3 is a system block diagram; and

Fig. 4 is a generic radio block diagram.

Detailed description of preferred embodiments of the invention

Thus, the invention relates to a method and arrangement using new technology that makes it possible to increase the capacity in the analog network to such a level that it is economically feasible to migrate the system to a digital system. The higher capacity potential in the digital system can therefore be used to its full capacity without jeopardizing the functionality for the analog subscribers. It should be understood that the present invention is equally applicable in the case where it is desired to migrate from a first digital to a second digital system (or, less likely, to a second analog system) of different standards. For convenience, and in the preferred embodiment of the invention, the first system is analog and the second is digital, while the invention is not limited in this respect.

Also, the term "frequency channel" or "channel" is to be

understood as a channel in the widest sense of the word e.g. including TDMA and CDMA channels.

The invention is based on a combination of four technical principles each contributing to an essential step in a "seamless" migration from an analog system to a digital system.

-The first principle is to employ a better use of the available frequency spectrum through installation of phased array antennas. The phased array antennas will enable the use of multiple lobes (from 8 to 100 or more per site). Each lobe can be treated as a cell which will make it possible to more effectively reuse the available frequency channels. The capacity can be further increased if the higher antenna gain in the phased array antennas is used to allow for a decrease of transmitted RF power from both the mobile terminals and the base with a factor of 2 - 40 depending on antenna gain and sectorisation in the system.

-The second principle is to make the frequency channel allocation adaptive. The term "adaptive" as used herein means that the base station is measuring the signal strength, quality and co-channel interference in each available channel and creates a dynamic bank with all channels ordered in a quality fashion. Whenever the base station is opening a traffic channel from one of the lobes to a mobile terminal the best channel is selected from the channel bank. This method eliminates complicated and inefficient frequency planning where fixed channels are allocated to each lobe (cell). In some systems a mix of fixed and adaptive channels can be used.

-The third principle is a way to utilize the capacity increase supplied by the multilobe function in relation to the capacity and processing time limitations that are present in most mobile switch systems. A separate control function is implemented in the base station which has the capacity to rapidly (in milliseconds instead of seconds) initiate and perform hand-off of a call in progress from one lobe to another without interruption or quality degradation of the call. This method will eliminate the capacity and processing time problems in the mobile

switch.

This function is also suitable if controllable lobes are used. In the case of controllabe lobes the lobe control is performed in the base station controller.

-The forth principle is the use of "generic" base station transmitters and receivers for the migration from an analog system to a digital system instead of the dedicated type of equipment used today. A generic transmitter or receiver is a unit with enough bandwidth and functionality for both analog and digital air interface. The transmitters and receivers are software function programmable to be able to execute traffic with analog or digital specifications. The generic function permits a seamless migration from an analog system to a digital system through reprogramming or change of parameters of the equipment from analog to digital function as frequency spectrum becomes available in the analog part of the spectrum. The reprogramming may be remotely controlled e.g. via the switching office.

As mentioned above the invention can also be used for migration between digital systems of different standards.

Following is a brief description of how the proposed migration method can be implemented in the field.

The migration is carried out as four different projects called A, B, C, and D. The four projects are interlinked together in such a way that the migration can be carried out in a smooth and seamless way.

PROJECTS BREAK DOWN:

<u>Project A:</u>

<u>Project A consists of the following activities:</u>

1. Study of site data delivered from Project C and selection of new sites or existing sites for upgrading.

2. Installation of new phased array antennas at the selected sites.

3. Modification of existing Radio Base Equipment (RBE) in order to permit multilobes and output power control. Installation of compander units in older RBE where this function is not implemented.

4. Installation of new Radio Base Controllers

5. New cell planning and frequency planning. Done by Project C. staff

PROJECT A. EQUIPMENT:

Project A. Masts and towers:
Item 1. Antennas

Antennas:
A typical antenna system is constructed from 2.5 x 2.5 m sections, each section having 8 RF multilobe inputs/outputs. Antennas of different sizes can be designed by using 1 or 2 or 3 or up to 48 sections which will be combined to an array antenna.

Each site will be installed with a combination of antenna elements corresponding to the required capacity at the site.

Existing masts/ towers are surveyed in order to collect structural data and locate available space for the new antennas. The collected data is used for planning of the antenna installation at each site.

Project A. Radio Base Equipment modification:

The RBE is modified with two different upgrades:

1. Installation of Multilobe Combiners.

2. A remote controlled attenuator is added on the output

transmitter amplifier for power control.

3. A new Radio Base Controller is installed for control of the new phased array antennas and output power control.

4. New cell planning will be performed as a part of Project C.

Project B:

Project B consists of the following activities:

1: Replacement of old existing high power car mounted units with new car mounted 0.1 W portable units. The replacement is proposed to be on a voluntary exchange basis subsidized by the operator in order to speed up the exchange process.

2. Sales of new 0.1 W handheld analog phones to new subscribers, if necessary, before the digital system can be put into operation. The analog low power phones can co-exist with the digital phones when the digital system have been fully implemented.

PROJECT B. EQUIPMENT:

Project B. Mobile unit exchange

The high power Mobile Units used in the system will be exchanged during a 1,5 - 2 year period. The exchange units will be 0.1 W handheld analog units with optional car mounting kit.

Project C

Project C consists of the following activities:

1. Data collection of system and site data from the system database.

2. Adjustment of system parameters.

3. Cell planning.

4. Definition of new sites.

5. Initiation of procurement for new equipment.

The network planning will be a continuing process running throughout the project and the first phase contains a complete network survey. The network survey will give the necessary input parameters for physical site planning as well as network planning aiming at optimizing system parameters, including the extra capacity and quality introduced with the new antennas.

Project C will continue during the whole process involving Project A, B and D for a continuous system performance upgrade.

Project D

Project D consists of the following activities

1. Installation of new analog/digital base stations at existing sites and at selected new sites.

2. Re-programming of Radio Base Controllers to analog/digital operation.

3. Sales of digital handheld and mobile units for the new capacity network.

4. Moving of 1 or 2 MHz of the existing frequency band to digital operation and preparation for change of more of the system frequency band to digital operation during the migration period.

5. Re-planning of the network for analog/digital operation and migration to a fully digital system.

6. Marketing activities in order to attract new customers to the new high capacity digital system.

PROJECT D. EQUIPMENT

Project D. New digital Radio Base Equipment

Installation of new Radio Base Equipment, common Site Equipment and re-programming of Base Station Controllers.

Below follows a more detailed description of the four principles that makes the seamless migration from analog to digital technology possible.

1. The first principle describes how the capacity is increased in the analog system with the existing cell sites. In figure 1 is shown a section of a phased array antenna to be installed in accordance with the present invention.

The radio tower or mast (not shown) is complemented with phased array antennas installed together with the existing antennas in order to permit continuous operation of the analog system during the installation of new hardware.

The phased array antenna comprises at least one section, such as shown in Fig. 1. It is built up on an aluminum framework 1 where 32 dipole antenna elements 2 are arranged in eight vertical rows, each row containing four dipoles 2. At each side of the rows are aluminum rods 3 placed. The aluminum rods 3 are acting as reflectors.

Each dipole row are fed in parallel from the lobe shaping unit. The lobe shaping unit is in its simplest form a Butler matrix or similar phase shifting equipment. The lobe shaping unit is shifting the phase of each individual input to the antenna inputs. The phase-shifted signals will when applied to all eight inputs radiate in a combined pattern at an angle from the antenna plane with a main power variable distribution width of about 15°. Each antenna array or section with eight dipole rows (inputs) can form eight independent lobes. Thus, using a 8 section antenna, 8 × 8 = 64 individually controllable lobes are obtained.

In figures 2A,B,C and D is shown different antenna lobe diagrams that may be obtained using phased array antennas. In figure 2A, six sections are used to generate 48 lobes or sectors. In figure 2B, three sections are used to generate 24 lobes. In figure 2C, three sections are used to generate 12 lobes. In figure 2D, four or eight sections are used to generate 8 lobes.

The described antenna has the following data:
Horisontal lobe width 15°
Vertical lobe width 14°
Antenna gain 22 dB

For received signals the same phase shifting technique is applied in order to direct the receiving lobe.

The phase shifting principle can also be used in a controlled mode where the lobe shaping unit is continuously monitored and controlled from the base station controller in such a way that the lobes can be continuously moved and pointed in different directions. Controlled lobes are specially useful with high speed mobile users where the lobe can be dedicated to follow the mobile as it is moving. The lobe controller will be able to use input signals and data from the base station controller (such as maximum signal direction, signal strength doppler speed signal) for optimal lobe direction for both transmission and reception. The lobe controller can also direct lobes and transmitter resources against interference sources (high power mobiles) in the form of nullifying 180° phase shifted transmissions.

Therefore, controllable lobes will further increase the system flexibility and permit further extension of the frequency reuse possibility.

The use of a highly directive high gain antenna system will make it possible to use low power transmitters in both up and down link (0,1W uplink and 1W downlink) which together with a minimum 48 dB fast adaptive power control function in both the uplink and the downlink will significantly improve the link budget and the power balance in the system. This is an important feature which will keep the co-channel interference under control and increase the possibility for channel frequency reuse.

In figure 3 a system block diagram is shown. The base station according to the present invention comprises conventional duplex filters, receiver and transmitter equipment as well as novel low noise amplifiers (LNA), a novel combiner including multichannel and single channel power amplifiers (MCPA, SCPA) and a novel base station controller (BSC).

The phased array antenna, the scanning lobe principle, the low noise amplifiers, the combiner and the base station controller principle are described more in detail and separately claimed in the above-mentioned patent applications.

New combiners are installed together with a lobe shaping unit and a new base station controller. The combiners will interface existing radio equipment to the new antenna system. Between the antenna array and the combiners a lobe shaping unit will be installed for phase control and lobe forming.

The combiner, the base station controller and the lobe shaping unit are described and claimed in separate patent applications as mentioned above.

The existing radio receivers and transmitters can be reused in the new system. It is however necessary to introduce a controllable power attenuation function on the transmitter output in order to reduce the output power to match the new phased array antennas. The output power is controlled from the base station controller and is adjusted to maintain a constant power level in the entire system. The controllable power feature will further increase the capacity in the system by reduction of interference between cells.

In order to fully use the capacity gain introduced by power control it may be necessary to remove very old high power car terminals from the system. As an example it can be mentioned that in the old NMT 450 system 15W terminals were used in the beginning and some of these are still in operation.

This first migration step will introduce an analog system with a significant increase in capacity allowing for use of frequency spectrum for an overlay digital

system.

2. The second principle is the adaptive frequency channel allocation function which eliminates inefficient and complicated frequency planning.

One scanning receiver is installed at every base station under control of the base station controller. The scanning receiver is combined with the lobe control unit and a scanning lobe is created which will contionously scan all frequency channels allocated to the specific base station. During the scanning the co-channel interference, signal strength, signal quality and lobe direction is measured and the result is stored in the base station controller channel memory. Each channel is given a rating which will rate the suitability for this channel to be used as a traffic channel in a specific direction. The channel register is continuously updated for each scan the scanning system performs.

When a traffic channel link is to be set up between the base station and a mobile subscriber unit the base station will select the best channel pair with respect to the parameters above from the channel register for the connection.

If a mobile terminal is communicating on a channel with a degrading signal quality the base station controller will immediately order the mobile terminal to change to a good channel.

This method will increase the number of available channels at a given moment since the lobe (cell) that is going to execute the traffic with subscriber has access to all the channels allocated to the base station.

In some systems the signaling principle between the base station and the mobile switch requires fixed channels allocated to each cell. This method works well in omnidirectional or trisector cells where a large number of channels are allocated to each sector/cell. In a base station with many lobes/cells a fixed allocation of channels to every lobe would create a low trunking efficiency which would restrict the capacity of the base station. This problem is solved by allocating 25% of the

available channels to the different lobes (cells) and the remaining 75% are collected in a channel pool controlled by the base station controller.

3. The third principle is a method to avoid the capacity and processing time problem in old mobile switching systems.

The switches used in mobile cellular telephony systems are often standard switches which have been given new functionaliy in hardware and software to work as main controllers over a mobile telephony system. The switches are however not designed to do the heavy amount of signal processing which is required in a mobile telephony system. Therefore the signal processing at hand-offs takes a very long time which is not acceptable in a multi lobe cell where hand-offs have to be quick. In existing systems the switches are often used to a high level of their capacity and it would create capacity problems if internal hand-offs between the lobes at the site were to be handled by the switch. The problem may be further amplified by the fact that the signalling protocoll used in the system specification is further slowing down the process.

The way to avoid the problems with the switch and at the same time use the switch in the system (the switch being a big investment) is to have the base station controller to do all internal switching and hand-off at the site. In order to do this the base station controller will have to emulate a type of base station with which the switch is programmed to communicate. The new base station controller will act as a dumb interface to the switch, meaning that the base station controller will emulate the response the switch is requiring for its commands and procedures. The base station controller will handle all the available radio channels and on its own perform hand-offs between the different lobes when so required. The switch will not be informed about an internal hand-off and the base station controller processor will keep track of the channel assigned by the switch and the actual traffic channel that is in use for the moment. In case there is a request from the switch concerning the active channel the base station

controller will report on the channel the switch is expecting to hear about.

If there is a need to make a hand-off to a nearby radio base station this request is transferred to the switch in the normal way and a normal hand-off between base stations via the switch is performed.

In this way it is possible to increase the capacity with more channels at each site without having to change the switch or make complicated and expensive changes to the switching system.

4. The fourth principle is the use of generic radio base station equipment and the final seamless migration to a digital system. The generic base station allows for dual mode traffic from the base station to the subscribers. The subscribers can therefore use their old analog or new digital handsets with the same base station.

The radio transmitters and receivers used for the digitalization are built in a generic way, meaning that their function can be both analog and digital within different system specifications.

Figure 4 shows a block diagram of the generic radio equipment in accordance with the present invention. On the receiver side, the radio equipment comprises a low noise amplifier LNA, band pass filters 1-4, mixers, and an A/D converter, a demodulation device and a digital signal processor. The receiver side is connected via local oscillators LO 1 and LO 2 and a synchronization reference device to a control supervision unit. On the transmitter side, the radio equipment comprises multichannel and single channel power amplifiers MCPA and SCPA and a combiner TXC, bandpass filters 5, 6, 7 and mixers as well as a D/A converter and a digital signal processor. The transmitter side is connected via the local oscillators and the synchronization reference unit to the control supervision unit which, in turn, is controlled by the base station controller (BSC1).

The radios are designed with RF amplifiers (LNA, MCPA, SCPA) and input amplifiers/filters (Band Pass 1-7) having enough bandwidth to cope with the different channel band-

widths used in different system standards. The signal processing is internally digital with bandwidth enough to cover the necessary frequency band. Modulation and demodulation is performed in the digital signal processors having capacity for most modulation/demodulation principles used in cellular standards today. Analog signals are digitized in the A/D converter before signal processing and is D/A converted to analog signals at the telephone line interface and the base station transmitter.

The radio principle can be both wide band and single channel technology. In the wide band solution the radio input/output stages have bandwidth enough for simultaneous processing of many channels.

The wide band solution is suitable in large systems where many channels are operated. The advantage is a lower hardware cost per voice channel but to a higher price per hardware unit.

The single channel solution is more suitable in systems where only a small number of channels are used or added. The single channel solution is more costly per voice channel but the cost per hardware unit is lower.

The generic radio transmitters are specially suited for use in system using the above described high gain phased array antennas since the transmitted power level is reduced from approximatley 50W to less than 1W per channel. This will significantly reduce the cost for the generic radio.

The functionality of the transmitter/receiver is preferably implemented in the software that is controlling the signal processors and is therefore not hardware dependent.

The generic radio equipment allows for a seamless transition to a digital system through the software controlled functionality which allows for continuous reconfiguration when more frequency spectrum becomes available for digital operation.

It is of course possible to implement the functionality of the transmitter/receiver also in hardware. Thus, the change of the generic base station from one type of system standard to another would require a change of the hard-

ware, which is generally less agreeable, but is not excluded from the scope of the present invention. However, the software option is preferred because the software may be controlled remotely e.g. from the mobile switching office or in an even higher layer.

Thus, the present invention provides a generally applicable method and an arrangement for converting a cellular telecommunication system from a first type to a second type, e.g. from an analog mobile telephony system to a digital mobile telephony system. Even though the invention has been described with a certain degree of particularity, various changes and modifications of the invention will be obvious to persons skilled in the art and are intended to fall within the scope of the accompanying claims.

CLAIMS

1. Method of converting a cellular telecommunication system of a first type to a cellular telecommunication system of a second type including mobile switching offices, base stations, and mobile units, characterised by the steps of:

increasing the traffic handling capacity of the first type of system;

introducing generic base station equipment capable of supporting both types of system; and

shifting the radio resource utilization as desired or necessary from the first type of system to the second type of system by reconfigurating the generic base station equipment.

2. Method according to claim 1, wherein the step of increasing the traffic handling capacity includes introducing multicell sites at at least one base station.

3. Method according to claim 2, wherein the multicell sites comprise phased array antennas having fixed or controllable multilobe properties.

4. Method according to claim 1 or 2, wherein said base station is capable of performing hand off between its cells associated therewith without involving any mobile switching office.

5. Method according to claim 4, characterised in that the base station is capable of emulating a base station of the first type of cellular telecommunication system in order to act as an interface to the mobile switching office of the first type of cellular telecommunication system.

6. Method according to any one of claims 2 to 5, characterised in that the base station measures the signal strength, quality, and interference of each available channel and ranges the channels in a dynamic channel bank for adaptive channel allocation.

7. Method according to any one of the preceding claims, wherein the step of increasing the traffic handling capacity includes decreasing the transmitted power of the base stations.

8. Method according to any one of the preceding claims, wherein high power, e.g. 15 W, mobile units are replaced by

lower power mobile units.

9. Method according to any one of the preceding claims, characterised in that the first type of cellular telecommunication system is an analog system and the second type of cellular telecommunication system is a digital system.

10. Method according to claim 9, characterised that analog mobile units are replaced by digital mobile units on a voluntary basis.

11. Method according to any one of the preceding claims, wherein the step of reconfigurating the generic base station equipment includes reprogramming of software of the base station.

12. Arrangement of converting a cellular telecommunication system of a first type to a cellular telecommunication system of a second type including mobile switching offices, base stations, and mobile units, characterised by:

generic base station equipment capable of supporting both types of system, and capable of being reconfigurated in order to shift the radio resource utilization as desired or necessary from the first type to the second type.

13. Arrangement according to claim 12, characterised in that at least one base station includes a multicell site.

14. Arrangement according to claim 13, characterised in that the multicell site comprises a phased array antenna having fixed or controllable multilobe properties.

15. Arrangement according to claim 13 or 14, wherein said base station is capable of performing hand off between its cells associated therewith without involving any mobile switching office.

16. Arrangement according to claim 15, characterised in that the base station is capable of emulating a base station of the first type of cellular telecommunication system in order to act as an interface to the mobile switching office of the first type of cellular telecommunication system.

17. Arrangement according to any one of claims 13 to 16, characterised in that the base station is capable of measuring the signal strength, quality, and interference of each available channel and ranging the channels in a dynamic channel bank for adaptive channel allocation.

18. Arrangement according any one of claims 12 to 17,

characterised in that the first type of cellular telecommunication system is an analog system and the second type of cellular telecommunication system is a digital system.

19. Arrangement according to claim 18, characterised in that the system is capable of handling both analog and digital mobile units.

20. Arrangement according to any one of claims 12 to 19, characterised in that the base station equipment comprises reprogrammable software for reconfigurating the base station.

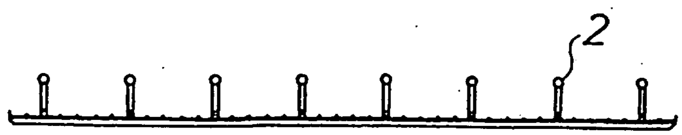


FIG. 1C

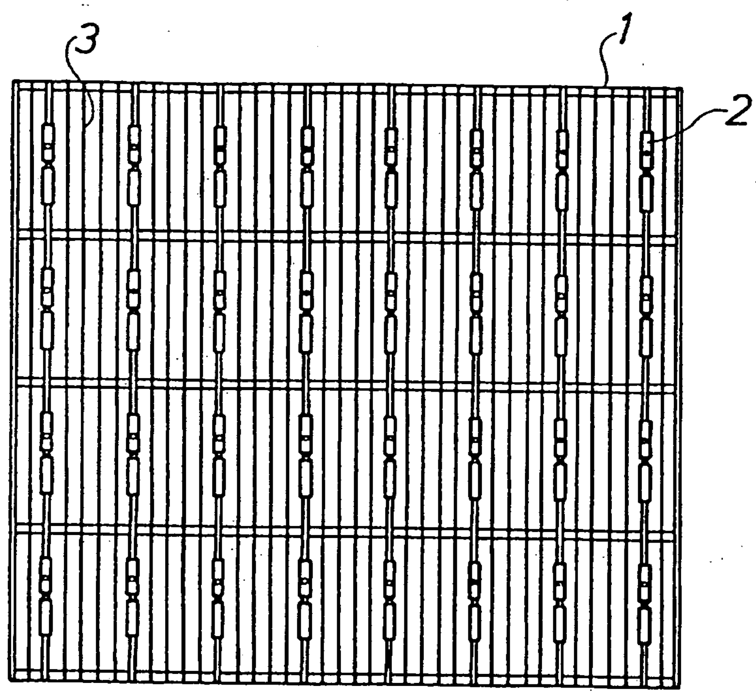


FIG. 1A

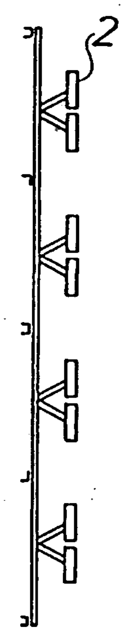


FIG. 1B

48 Sectors

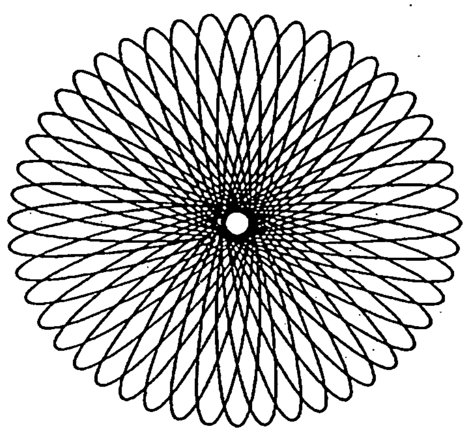


FIG. 2A

24 Sectors

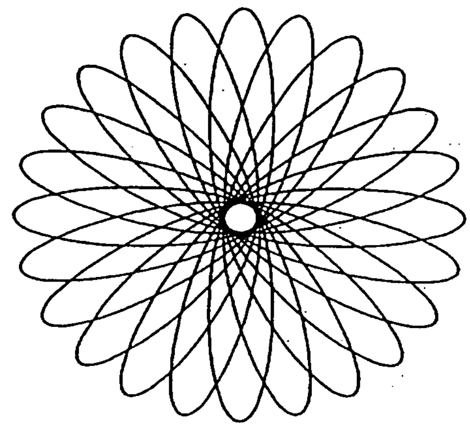


FIG. 2B

12 Sectors

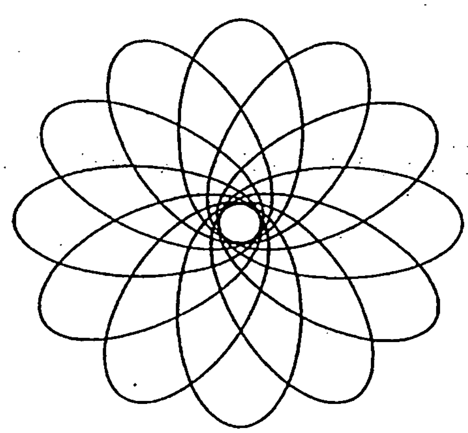


FIG. 2C

8 Sectors

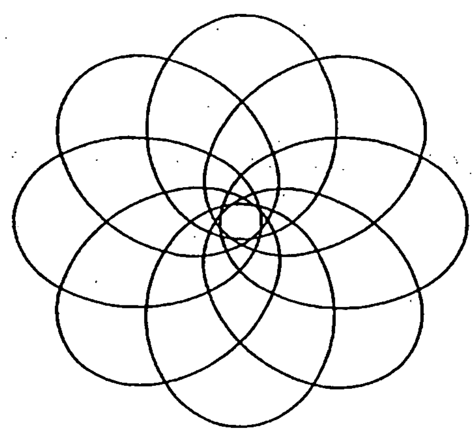


FIG. 2D

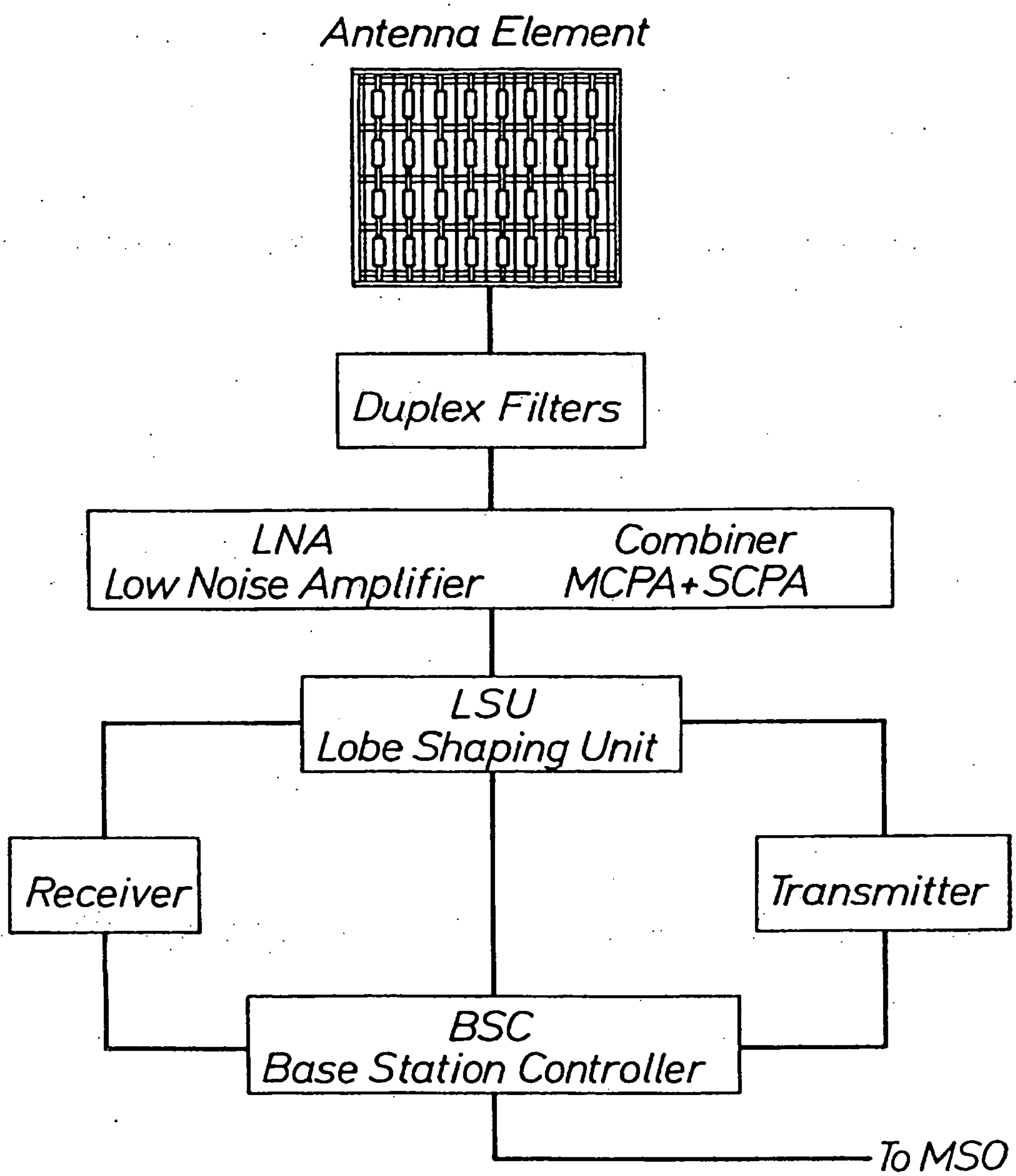

Antenna Element
Duplex Filters
LNA
Low Noise Amplifier
Combiner
MCPA+SCPA
LSU
Lobe Shaping Unit
Receiver
Transmitter
BSC
Base Station Controller
To MSO

FIG. 3

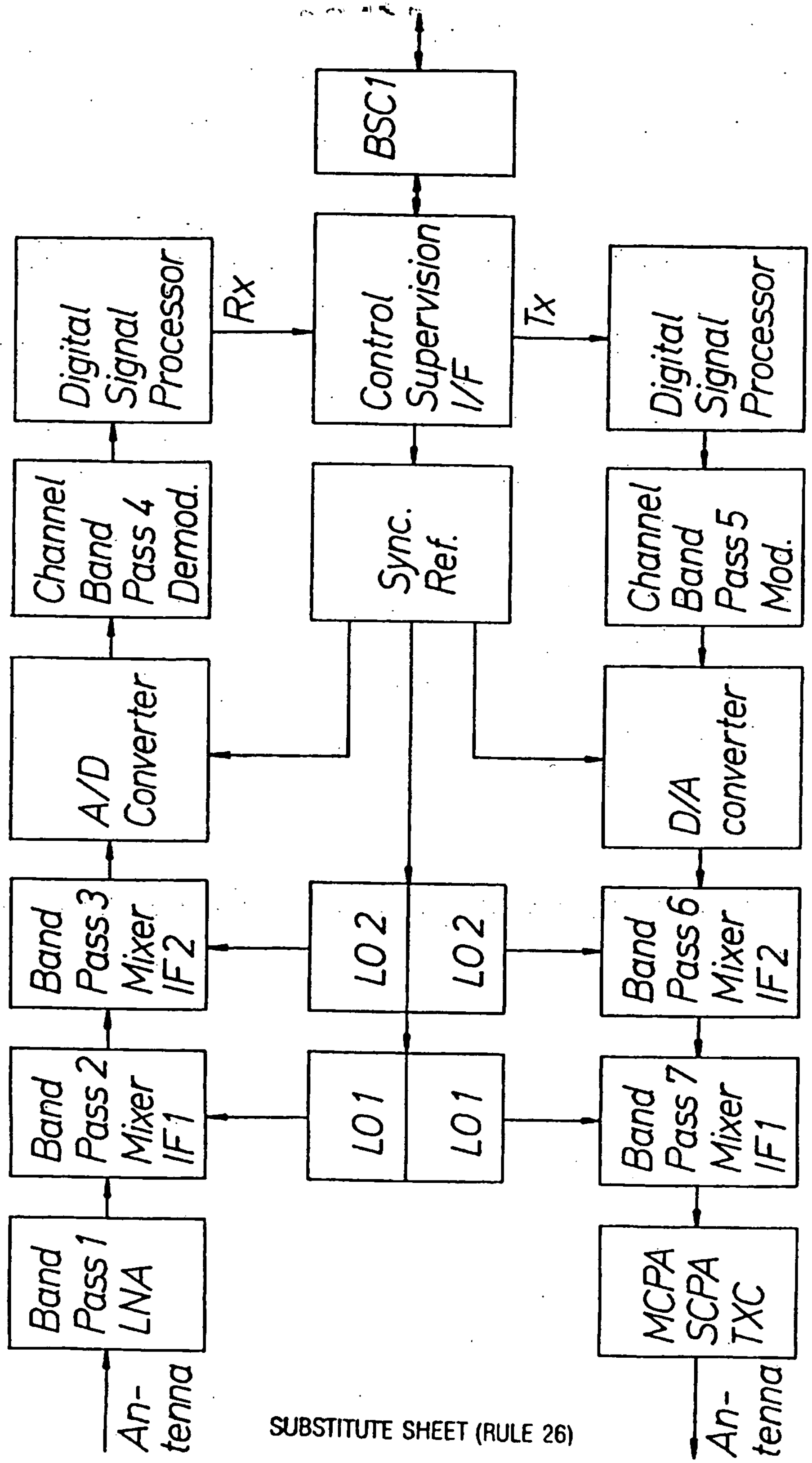

BSC1
Control Supervision I/F
Rx
Tx
Digital Signal Processor
Digital Signal Processor
Channel Band Pass 4 Demod.
Channel Band Pass 5 Mod.
Sync. Ref.
A/D Converter
D/A converter
Band Pass 3 Mixer IF2
Band Pass 6 Mixer IF2
LO 2
LO 2
Band Pass 2 Mixer IF1
Band Pass 7 Mixer IF1
LO1
LO1
Band Pass 1 LNA
MCPA SCPA TXC
An-tenna
An-tenna

FIG. 4